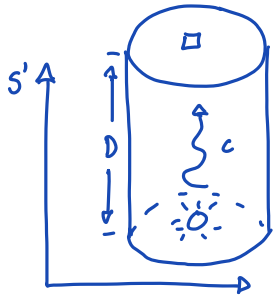


Ch. 4 Time Dilation

↳ Means that moving clocks turn slow

The Light Clock



c : Speed of light relative to S' ?

$$c = c$$

$$c = \frac{2D}{\Delta t'} \quad \therefore \left[\Delta t' = \frac{2D}{c} \right] \text{ - Time interval between 2 events.}$$

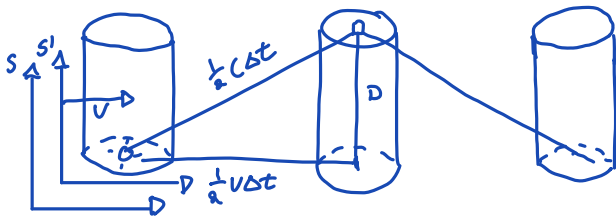
Event 1: Flash of bulb

Event 2: Detection of flash

{ The 2 events occur at the same place relative to S

The light clock moves at speed V relative to S

$$\Delta x' = x_2' - x_1' = 0$$



P.T Yields....

$$\left(\frac{1}{2} c \Delta t \right)^2 = D^2 + \left(\frac{1}{2} V \Delta t \right)^2$$

$$\left[\Delta t = \frac{\Delta t'}{\sqrt{1 - v^2/c^2}} \right] \text{ when } \Delta x' = 0$$

$$\Delta t > \Delta t'$$

$$\frac{1}{4} (c^2 - v^2) \Delta t^2 = D^2 = \frac{c^2}{4} \left(1 - \frac{v^2}{c^2} \right) \Delta t'^2$$

$$\Delta t^2 = \frac{4D^2}{c^2} \cdot \frac{1}{(1 - v^2/c^2)}$$

$$\Delta t = \frac{2D}{c} \cdot \frac{1}{\sqrt{1 - v^2/c^2}}$$

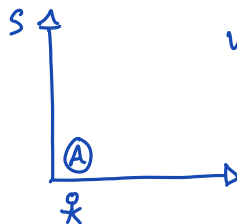
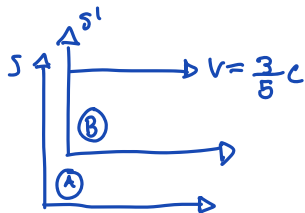
$$\Delta t > \Delta t'$$

Moving clock runs slow as observed by those in S frame!

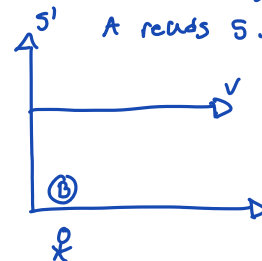
When we compare (S') 's clock tick rate with that of (S) 's tick rate.

Ex P.2

a.) Clock A at 5 am, what does B read in our frame



$$v = \frac{3}{5}c \quad \therefore \quad \frac{v}{c} = \frac{3}{5}$$



Notice:

A 2nd observer in clock A's frame reads clock B's time when clock A reads 5 AM.

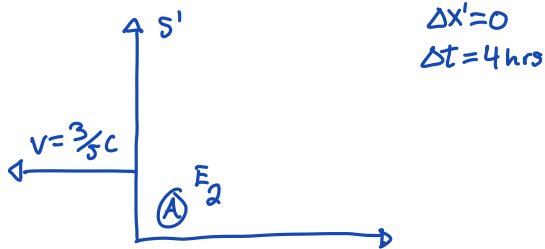
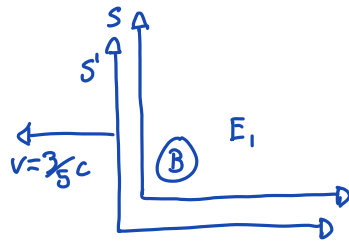
a.) $\Delta t = 5 \text{ hrs}$, $\Delta x' = 0$

ⓑ reads 4 AM $\Delta t' = 4 \text{ hrs}$

$$\Delta t' = \Delta t \sqrt{1 - \frac{v^2}{c^2}}$$

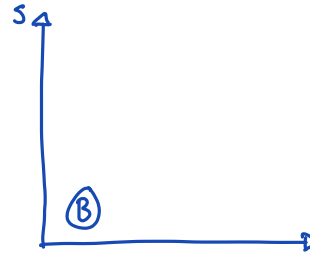
$$\Delta t' = 5 \text{ hrs} \sqrt{1 - \left(\frac{3}{5} \right)^2} = 5 \text{ hrs} \cdot \frac{4}{5} = 4 \text{ hrs}$$

b.) What does clock A read in clock B's frame?



$$\Delta x' = 0$$

$$\Delta t = 4 \text{ hrs}$$



$$\Delta t' = \Delta t \sqrt{1 - v^2/c^2}$$

$$= 4 \text{ hrs} \sqrt{1 - \left(\frac{3}{5}\right)^2} = 4 \text{ hrs} \cdot \frac{4}{5} = 3 \text{ hrs}, 12 \text{ mins}$$

\textcircled{A} reads 3:12 AM, $\Delta t = 3.2 \text{ hrs}$

Notice:

A 2nd observer in clock B's frame reads clock A's time when clock B reads 4 AM.

A second clock A observer reading B's clock when A reads 5 AM IS NOT the same as a second clock B observer reading A's clock when B's reads 4 AM.